DISCUSSION PAPER

EFFECTS OF CLIMATIC CHANGE ON WORLD INDUSTRY, TRADE AND INVESTMENT

by

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Effects of Climatic Change on World Industry, Trade and Investment: A Discussion Paper

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Foreword

This paper was prepared by Derek Ireland of Consumer and Corporate Affairs Canada at the request of the Environment and Sustainable Development Program of the Institute for Research on Public Policy, Ottawa, Canada. It was commissioned to serve as a background document and stimulus for discussion in the workshop on "Industry, Trade and Investment" at the World Conference on the Changing Atmosphere held in Toronto from June 27 to June 30, 1988. Mr. Ireland undertook this work in a personal capacity and the views expressed are not necessarily those of the Government of Canada. The author and Institute welcome comments on the paper.

Executive Summary

There is a growing body of scientific evidence that the emission of greenhouse gases is having serious consequences for the world's climate. For the world as a whole, the greenhouse effect is expected to result in temperature changes (averaged across latitudes and countries) of from 1.5 ° to 4.5 °C. Marked regional variations in the amount of warming are anticipated. Global sea level is expected to rise substantially by between 20 and 70 cm or more, and precipitation patterns and the distribution of rainfall across continents and latitudes are expected to change markedly. Climatic change also will result in major increases in the probabilities of extreme events: flooding, major storms, drought etc. All regions of the world are expected to be affected to some degree but the greatest changes in the climate will occur in the higher latitudes. These changes are expected to take place over the next 40 to 60 years, which represents an unprecedented rate of change compared to past changes in weather patterns.

Consistent with the strong interrelationships between the environment and the world's economy, the climatic changes associated with the greenhouse effect will hold significant—and for some countries potentially devastating consequences—for the economy and for global distribution of trade, industry and investment. Climatic change will have significant downward effects on world production and gross national product and on the per capita disposable income of the world's residents. Permanent economic losses will result from production decreases for specific economic activities, as well as higher costs of production, resulting in lower net incomes and GNP, for other activities. Other economic losses will result from the diversion of investment capital from revenue generating to non-revenue generating—but absolutely essential—uses such as dikes and other protective works, the relocation of facilities inland, research and development

needed in response to climatic change, labour force relocation, and funds to take care of refugee populations.

Climatic change will also negatively affect human health and labour force productivity, and the decision-making of business people, farmers, fishermen and government officials who are likely to become more cautious and risk averse, and less interested in maximizing sales, profits and economic benefits. These consequences will add to the downward effects on world production. The primary resource sectors: agriculture, forestry, fishing and wild animal harvesting; and the primary manufacturing industries dependent on these resources for intermediate inputs, will be the economic activities most directly affected by climatic change. However, through inter-industry linkages, multiplier effects, and international economic interdependence, no sector of economic activity will be totally immune.

Climatic change will also have substantial effects on international markets. The drop in agricultural production could result in expanded trade in farm products, some strengthening in agricultural prices, and perhaps some increases in net income for farmers and agricultural regions less directly affected by climatic change. Alterations in the climate will have mixed effects on the production of and markets for non-farm commodities. However, in light of the overall downward effect climatic change on world GNP, the greenhouse effect likely will not provide a panacea for the current slump, historically low prices and unfavourable longer term prospects in commodity markets.

The world's financial markets can be expected to cope with the economic forces brought into play by climatic change, but the methods of response could lead to sub-optimal patterns of investment throughout the world. Atmospheric change, and the uncertainties associated with its magnitude and rate of change, will provide an additional measure of risk to any investment and therefore will result in higher costs of capital and interest rates. Climatic change will have mixed effects on transportation economics but the overall consequence could be higher transportation costs to producers and consumers. Consumer prices will increase, the result of: pressure on governments to raise the prices of fossil fuels; higher transportation and interest costs; and the anticipated significant declines in agricultural and forestry production.

While the effects on world production will be substantial, atmospheric change will certainly have an even greater impact on the distribution of production, GNP and per capita disposable income among the regions and countries of the world. The actual economic impacts on specific countries and regions will depend not only on the country specific magnitudes and rates of atmospheric change brought about by the greenhouse effect. These impacts will also depend on a host of other economic and social variables which when combined dictate how a country responds and adapts to an external shock.

As a general statement, developed countries will be able to respond more effectively than developing countries to the economic effects of climatic change. In many instances, developed countries may be less directly affected by warming, precipitation changes, and sea level rise. More importantly, the developed world generally has the financial resources, educational and technological base, and political and institutional maturity to cope with the economic impacts and social dislocations. The need to relocate

substantial numbers of people will add to the burdens placed on developing countries. Sea level rise and other aspects of the greenhouse effect could add substantially to the world's refugee populations and exacerbate the already very difficult conditions in Third World cities.

Without effective interventions by national governments and the international community, climatic change can be expected to: increase per capita income disparities between the developed and developing worlds; further heighten the growing income differentials within the developing world between the NICs and least developed countries; exacerbate the international debt crisis; and heighten income disparities between developed countries and among regions within developed countries . In short, without well designed limitation and adaptation strategies, the greenhouse effect likely will leave us with a less equal and more dangerous world.

Mitigating the economic impacts of atmospheric change will require a judicious mix of limitation and adaptation strategies. The formulation and implementation of strategies must be guided by a full appreciation of the complexity of the processes brought into play, the interactions among the various environmental developments, the linkages and feedback relationships among the various economic and environmental variables, and the relevant inter-industry and inter-country linkages. Limitation strategies to reduce fossil fuel consumption and the rate of deforestation must be based on a realistic appraisal of the economic forces which govern these processes.

While limitation strategies must play a role, adaptation strategies are also needed to mitigate the economic effects of climatic change. Even if fossil fuel consumption and the rate of deforestation are substantially reduced in the near term, the earth will continue to warm, although at a reduced rate, for many years into the future. Scientific research and modelling should focus on reducing the wide ranges, error bounds and uncertainties associated with current forecasts, better modelling the country specific effects of climatic change, and better identifying the interactions among the greenhouse effects and between climatic change and other environmental trends. Economic research should adopt a holistic "general equilibrium" approach and must not be delayed pending improved scientific models and forecasts.

In formulating and implementing adaptation strategies, first priority should be given to:

- Identifying the countries and regions within countries which are most vulnerable to atmospheric change, and making climatic change an integral part of the planning process for these countries and regions.
- Developing the appropriate economic research methods and models to properly forecast the economic consequences of the greenhouse effect.
- Information dissemination strategies to ensure that business people, labour unions, national governments, international institutions and the public at large are working from the same information base.

- Special development strategies for the coastal areas which are most at risk from sea level rise.

- Development of measures through which the countries least affected and most responsible for climatic change (chiefly the developed world) compensate the countries most seriously affected (mainly the developing countries).

Climatic change is a long-term problem and therefore may not receive the attention warranted from politicians, the media and the public. Awareness of the greenhouse effect can be heightened, and strategy implementation could begin in the near term, through linking climatic change to more immediate policy concerns related to acid rain, depletion of the ozone layer, afforestation, agricultural subsidy programs, food security in developing countries, and the international debt crisis.

1. Introduction

A major world conference on "The Changing Atmosphere" was held in Toronto, Ontario, Canada from June 27 to June 30, 1988. One of the workshops at the conference addressed the economic implications of atmospheric change for world industry, trade and investment. The workshop's major objective was to examine the character and extent of the impacts of climatic alteration on industry, trade and investment, and the options for and desirability of managing these economic activities so as to minimize threats to the resource base from atmospheric change.

The purpose of this document was to provide to the workshop a discussion paper on the economic implications of the anticipated changes in the climate. The paper provides no definitive answers–our research, models and understanding of the interactions between the climate and the economy are not sufficiently advanced to provide final answers at this time. Rather, the paper's intention was to lay out some of the potentially relevant questions and issues with respect to economic impacts and responses and thereby to facilitate the discussion of the economic consequences of atmospheric change at the Industry Trade and Investment (ITI) workshop and in the conference.

With the completion of the Conference, the author has prepared a second draft for distribution to selected experts in Canada and other countries. Once comments have been received, the Institute for Research on Public Policy intends to publish the final document as part of their series of papers on the environment and the economy.

This paper addresses in a preliminary manner the following questions and issues.

What are the probable consequences of atmospheric change for world aggregate production and income and for per capita disposable income?

How will the patterns and distribution of industry, trade and investment be affected?

Which sectors of economic activity are likely to be most influenced by climatic change? Which will be least affected? What are the reasons for these differences in sectoral impact?

Which continents, country groups and countries are expected to be most affected by atmospheric change? Least affected? Are there likely to be winners and losers, or will the vast majority of countries be affected more or less equally?

How are financial markets and investors likely to respond to changes in the climate? How will business decisions on where to locate and where to do business be influenced?

To what extent will world populations and human settlements be affected, and what are the economic consequences of these demographic impacts?

How will research and development, the development and application of new technologies, and technology diffusion be influenced by atmospheric change?

What effects will the climatic changes have on transportation routes, infrastructure and economics?

What limitation and adaptation strategies are available for adoption in order to mitigate the economic consequences of climatic change? What are the factors which should be considered in preparing policy options, strategies and recommendations? What are the obstacles to strategy implementation and how can these be overcome? What are the economic and geopolitical issues and realities which must be addressed in preparing economic strategies?

In formulating policy options and strategies for mitigating the economic consequences of atmospheric change, what weight should be given to limitation strategies relative to adaptation strategies?

In preparing this paper, the author has drawn extensively from the sources listed in the bibliography. References are not included in the text, in order to enhance readability and brevity.

2. Climatic Changes Relevant to the World Economy

Consistent with the strong relationships between the environment and the world's economy, most of the climatic changes associated with the greenhouse effect will hold significant—and for some countries potentially devastating—effects for the economy and for the global distribution of industry, trade and investment. (For example, the very existence of the Maldives could be in peril.) This section will attempt to briefly summarize the climatic changes which appear to hold the greatest significance for economic activity. Readers are asked to refer to the source documents listed in the bibliography if further information on projected climatic change is required.

The scientific community is beginning to develop some consensus around the causes, direction of change and the range of possible outcomes for the key atmospheric variables on a global scale. The greenhouse effect is caused by increases in global atmospheric concentrations of certain trace gases, most notably carbon dioxide, methane, nitrous oxide and chlorofluorocarbons. These increases are largely the result of man's activities, in particular the growing use of fossil fuels (oil, gas and coal), the utilization of chlorofluorocarbons as solvents, refrigerator fluids, spray can propellents, and foam packaging, and the substantial deforestation, desertification and other major land use changes which have taken place over this century.

There is growing and reliable evidence that atmospheric concentrations of these gases have expanded substantially over the past 100 to 200 years. Unless appropriate limitation strategies are adopted, atmospheric concentrations are anticipated to continue to grow indefinitely. The industrialized nations are responsible for most of the past and current emissions of carbon dioxide, the most important greenhouse gas. However, the policies and strategies of development in the Third World may to a large extent determine

future CO_2 emissions. Strategies to reduce CO_2 emissions through reducing fossil fuel consumption in the developing world will come up against strong pressures to increase energy use to meet economic development objectives and consumer demands.

Climate models have been developed to examine the sensitivity of the climate to increasing greenhouse gas concentrations. Confidence is growing in their global results. For the world as a whole, the greenhouse effect is expected to result in temperature changes (averaged across latitudes and countries) of between 1.5° C and 4.5° C; this temperature gain could take place in a relatively short period, perhaps 40 to 60 years. The range of temperature values suggested by the models for the year 2030 is from 0.8° C to 6.4° C warmer than at the present time. Residual equilibrium warming in the middle of the range means the world's surface temperature on average would be warmer than at any time within at least the last 120,000 years. Moreover, the rate of change would be unprecedented.

A second consequence which will have global implications is the impact of warming on global mean sea level. Because of global warming, global sea level is expected to rise substantially over the next century compared to the modest rise of 10-15 cm estimated for the past 100 years. The current evidence suggests the sea level rise from now to the year 2030 could be between 20 and 70 cm, but some projections suggest the increase could be as much as 3 metres over the next 50-70 years.

The primary effects on coastal environments will result from increased rates of coastal erosion, salt intrusion into surface and groundwater systems and coastal ecosystems, wetlands loss, and temporary and permanent flooding, including significantly increased risks from storm surges. This last consequence is particularly significant for environmental and socioeconomic impacts. Slow changes in mean climate or sea level can result in large increases in the probabilities of extreme events: flooding, major storms, drought, etc. The projected sea level rise will have particularly serious consequences for deltaic areas where substantial acreages, which are densely populated and intensively used, are barely above sea level.

The global evidence is less conclusive on whether mean precipitation will increase or decrease for the world as a whole. However, as will be discussed below, precipitation patterns and the distribution of rainfall across continents and latitudes are expected to change substantially. The effect of climatic change on precipitation and the world's water resources probably is the greatest unknown in the equation. Scientists however are already concerned with the falling levels and flows in many of the world's major water systems. If climatic change should accelerate this downward trend, the implications for irrigated agriculture, inland transportation and the provision of safe drinking water to communities, could be very serious indeed. Other more direct effects of climatic change could include alterations in fish migration patterns and the potential that some animal species could become extinct.

Virtually all scientific studies of the greenhouse effect indicate that, except for sea level rise, the climatic changes will vary significantly among regions. Unfortunately, because of the limitations of current climate models, it is not possible at this time to identify how climatic changes will vary among specific multi-country regions and

countries. The greatest uncertainty surrounds the regional precipitation forecasts. The model results to date are limited to latitudinal impacts, and have not been able to address the marked longitudinal contrasts in climate across continents (for example between the moist temperate climate of Southwestern British Columbia and the semi-arid continental climate of Southwestern Saskatchewan). Longitudinal contrasts in the final analysis could be just as important as latitudinal differences. The following paragraphs briefly summarize the latitudinal consequences which appear most relevant to this analysis.

The *mid-latitude regions* between 30 and 60 degrees latitude will experience warming which is somewhat greater than the global average. Winter temperatures are anticipated to increase more than summer temperatures. Changes in precipitation and soil moisture are not clear, but soil moisture in summer could decrease because of enhanced evapotranspiration. As well, precipitation could be reduced in summer.

One of the most significant effects could be on the mid-latitude forests. If the temperature change is rapid, dieback of trees will result, with replacement of successional trees supporting smaller standing crops. If climatic change occurred slowly over two to five centuries, trees could probably adapt through advancing the rate of reproductive success along the forest borders. However, with more rapid change, forests may not be able to move north because suitable soils cannot be created quickly enough. Because of these factors, more forests could require planting or enhanced management to retain the forest in a productive mode. Costs of production could increase significantly; such labour intensive practices may not be economical for formerly unmanaged forests.

For agriculture, the greenhouse effect will cause intra-regional shifts in productivity. The dangers are that agricultural technologies and the availability of new varieties will not keep up with the rate of climatic change, and that agriculture may be forced on to less fertile soils.

Climatic variability is already a problem for the *semi-arid tropical regions* from 5-35° North and South. Atmospheric change is expected to increase weather variability and uncertainty. Precipitation could be enhanced in some places but more in terms of intensity than frequency. In other areas rainfall could decline, thereby accentuating the potential for drought and the desertification process. For areas where agriculture is already marginal and high risk, productivity decreases could further aggravate their current problems in meeting basic nutritional needs.

The greenhouse effect will result in further warming of the *humid tropical regions* near the equator. The warming, while somewhat less than the global average, would be accompanied by an increase in rainfall perhaps in the range of 5 to 20 percent. Since the region is already often too hot and wet, even modest climatic effects, when combined with shifts in the geographical patterns of rainfall and cloudiness, could have serious economic consequences. Since the warming could lead to increases in evapotranspiration, more drought stress could arise in many regions of the humid tropics.

The largest climatic effects will occur in the *high latitude areas* north of 60° N and south of 60° S. Warming in winter will be two times or more the warming expected in other latitudes and rainfall and cloudiness likely will also be enhanced, especially in

winter. Significant changes in pack ice conditions are anticipated and in some areas the warming could result in the withdrawal of summer pack ice. Permafrost, particularly in northern Canada and Siberia, could slowly disappear. Changes in Arctic pack ice could result in significant climatic changes in lower latitudes. However, the potential direction and magnitude of these changes is not known at the present time.

It should be emphasized that climatic change will not take place in isolation from other environmental trends. The amounts of other atmospheric and aquatic pollutants (not directly related to the greenhouse effect) will continue to expand as a consequence of industrial growth. Further research work is needed on these other environmental trends and their interactions with and implications for climatic change.

To summarize, significant increases in global mean temperature and sea level are expected to occur over a comparatively brief 40 to 60 year period. The magnitude and rate of change could be larger than any experienced in human history. Beyond the magnitude of change and its environmental and economic consequences, the formulation of economic strategies must also take account of the rate of change which is virtually unprecedented, the many remaining unanswered questions regarding the magnitude and rate of change and their regional consequences, and the effects of climatic change and sea level rise on the probabilities for extreme events.

Economic planning is never easy, but planning in the context of rapid change, significant uncertainty and high risk is particularly problematic, both for planners and for the audiences which are the targets for those plans.

3. Global Trends

It is necessary to analyze climatic change and their implications for the economy within the context of global economic trends in industry, trade and investment. Climatic change will not occur in a vacuum. Climatic changes and their anticipated economic effects will affect—and be influenced—by other developments in world industry, trade and investment. Atmospheric change could accentuate or mitigate global economic trends. Causation, however, could also be in the opposite direction. Global economic developments could help to offset some of the potential economic consequences of climatic change.

The following sub-sections do not attempt to provide a fifty-year global forecast. Rather, they provide a listing of current economic developments which are important today and in some instances could continue to be important over the next 30 to 50 years, when climatic changes will be having their full impact on the world's economy and human settlements. The listing, which is divided into six sub-sections, is drawn from the sources provided in the bibliography, particularly Volume I of the Royal Commission on the Economic Union and Development Prospects for Canada.

Economic and Environmental Linkages

Environmental and economic problems have become global in nature and closely intertwined. For example, motivated in part by the need to pay off its international debts, Brazil is accelerating the deforestation and industrial development of its upper Amazon region, with serious consequences for the environment and economies of the rest of South America and perhaps world-wide.

The world's tropical forests are diminishing each year and deforestation is having serious environmental and economic repercussions on a global scale.

Soil deterioration and desertification are affecting upwards of 100 countries. The process is most serious in sub-Saharan Africa, northwestern Asia and the Middle East.

Population and Human Settlements

While population growth rates are levelling off in most developed and many developing countries, world population is continuing to grow exponentially and could approach 10 billion people by 2050. The developing world will account for over 85% of the world's population in that year.

Most of these population gains will need to be accommodated by the world's cities. Urban growth in many developing countries will be nothing short of explosive.

Refugee populations are growing in many parts of the world, placing major financial, economic and social strains on host countries and on the international community.

Commodities

Agricultural production has displayed impressive gains in the developed world and many developing countries. For many countries and products, over-supply rather than supply shortages now is the norm. Recent developments in biotechnology hold the potential for generating further dramatic advances in food production. The overriding concern is the unequal distribution of world production capacity in relation to population, the limited foreign exchange resources of food deficit countries, and national and international bottlenecks in transportation and distribution.

The agricultural policies of many countries—developed and developing—are seriously flawed. Over-production and heavy subsidization of farm production in the developed world indicate that developed country governments find it difficult to come to terms with the new realities in agriculture. Some developing countries emphasize export crops vulnerable to low prices and uncertain international markets, at the expense of small-holder agriculture to satisfy domestic nutritional needs. Other developing countries are attempting to become self-sufficient in food in the face of marginal agricultural resources. Still others have farm price policies which strongly favour their urban populations over agricultural producers.

After rising sharply over the post war period, world demand for and production of fossil fuels have levelled off in the past few years. However, soft markets and depressed prices could result in renewed growth in fossil fuel demands and production over the short to medium term.

Because of greater efficiencies in use, recycling and the development of new sources of supply, markets and prices for industrial commodities will likely remain soft for the medium term at least. The initiation of sea-bed mining on a major scale—in response to concerns about security of supply—could further depress commodity prices.

Trade and Technology

Despite recent efforts at protectionism, autarky and technological nationalism, economic interdependence is continuing to grow and virtually all countries now recognize they must trade in order to provide ever higher standards of living for their people. The proportion of goods and services which cross national boundaries currently exceeds 20% of world output, compared to 11% in 1950. The enormous advances in science and technology, coupled with political realities and economic common sense, mean that our economic dependence on each other will continue to advance.

While growing economic interdependence is recognized, developing countries continue to shoulder most of the burden of protectionism. Because of high tariff and non-tariff barriers in developed countries, developing countries are not able to fully capitalize on their comparative advantage in many commodities (e.g. sugar cane), in down-stream processing of natural resources, and in labour-intensive manufacturing.

The world has become more interdependent in economic, social and technological matters but political will and international institutional machinery have not kept pace with growing interdependence.

The traditional distinctions between sectors of economic activity and occupations are becoming blurred. This is particularly true for science and technology where the new technologies tend to be generic, not sector specific. This trend is also found in international trade where trade in services, either on their own or in combination with goods, are becoming important sources of foreign exchange for many countries.

The last decade has seen a rapid acceleration in the pace of technological advance. This trend will continue, led by microelectronics and communications technologies and by biotechnology, but broadening into many other fields. The future will also see accelerated rates of diffusion of these technical advances to other industries and countries.

With the growth in leisure time and disposable incomes, tourism has become an important international industry in its own right and a significant source of foreign exchange for many developed and developing countries.

As noted above, for most non-farm commodities such as forest products, metals and non-metallic minerals, world industrial demands are shrinking. Slower economic growth in the 1980's compared to the earlier post-war decades is making some contribution to reducing demands. However,the major reason is that industrial production is steadily switching away from heavily material-intensive products and processes.

In manufacturing, the substitution of knowledge and capital for manual labour is accelerating and the industrial structure is shifting from industries that were primarily

labour-intensive to industries that from the outset are knowledge-intensive. In addition, economies of scale and economies of management are no longer critical to low cost production and international competitiveness. Lower labour costs are becoming less of an advantage in international trade. Instead, the cost of capital, combined with entrepreneurship and technology, are taking on greater importance in determining international competitiveness.

International Finance and Third World Development

The crisis in international debt management, which first surfaced in 1981, could be with us for a long time. Initiatives to date have been piecemeal, and in the view of most commentators, have provided little more than short-term "band-aid" solutions

In the recent past, international financial markets have proven to be fairly responsive and adaptable to external shocks (the three oil crises, the United States trade and government deficits and the massive shifts in exchange rates). In contrast, labour markets and the international markets for commodities, industrial products and services have shown less flexibility.

Official development assistance in recent years has stagnated in absolute terms, and most donor countries fall well short of agreed targets. As a result, development finance from multilateral and bilateral sources is meeting only a fraction of the massive capital requirements of the Third World. Commercial lending and lending by export credit agencies also have fallen sharply. Because of debt repayments, many developing countries which are most in need are suffering from a net outflow of capital.

Developing countries are largely dependent on the export of natural resources to satisfy their critical import requirements and to pay off their international debts. Because of this dependence, the developing world has absorbed most of the burden of unstable markets, declining prices and the environmental problems associated with the production and export of primary and semi-finished goods.

For many developing countries, deteriorating terms of trade, stagnating flows of aid, and growing protectionism in the developed world economies have caused severe external payment problems, have retarded economic growth, and undermined development prospects and hope for the future. The stringency of external finance has already contributed to significant declines in living standards in many developing countries.

Transnational corporations (TNCs) now play an important role as owners, as partners in joint ventures, and as suppliers of technology in the mining and manufacturing sectors of many developing countries. TNCs are particularly prominent in the more environmentally sensitive areas such as petroleum, chemicals, metals, paper and automobiles, and now dominate world trade in many primary commodities.

Employment and Income

Changes in production and employment are no longer positively correlated and the two variables often move in opposite directions. The adoption of labour-saving technologies and automation allow primary and industrial goods to be produced with ever decreasing amounts of labour. The trend towards rising productivity and labour saving technologies is most obvious in developed countries where labour force growth is a fraction of historical levels. However, developing countries cannot ignore these trends if they are to remain internationally competitive in goods production.

The excess labour no longer required for primary and secondary pursuits must be absorbed by the service sector, by the ranks of the unemployed, and by increased leisure time. Rapid urbanization, especially in Third World countries, is one consequence of the uncoupling of production and employment trends.

Despite the economic advances of the past half decade, unemployment rates in many European countries and Canada have remained above traditional and politically comfortable levels, and the developed world continues to be haunted by the danger of "stagflation". Western nations therefore continue to look inward and have become preoccupied with their own economic concerns; they are giving less attention to the more serious economic, development and environmental problems of the Third World and the total international community.

Disparities in per capita income and living standards between countries are widening, not diminishing. Large disparities historically have existed between the developed and developing worlds. These are now being joined by marked disparities in living standards and development prospects within the Third World between the newly industrializing countries and the least developed nations. Many of the latter have shown that, while living standards have the potential to rise, improvements in per capita and family income are not inevitable. As noted earlier, many developing countries have suffered dramatic declines in per capita income over the past decade, as a consequence of heavy debt repayments, economic austerity programs, soft export markets, and high population growth.

4. Issues Analysis

The purpose of this section is to explore in some detail the issues posed at the start of this paper and to evaluate, in light of the current evidence, the possible implications of climatic change for world industry, trade and investment.

Losses in Aggregate Production. There is no question that the climatic changes, and the first order effects identified in the literature, will have significant downward impacts on world production and gross national product and on the per capita disposal income of the world's residents. Economic losses will arise from a number of sources. A partial listing would include:

- Diversion of investment capital from revenue generating activities to non-revenue generating—but absolutely essential—uses such as dikes and other infrastructures needed to protect coastal areas, construction of new infrastructure and facilities to replace structures made obsolete by sea level rise and other atmospheric changes, research and development expenditures needed in response to climatic change, labour force relocation and retraining, and funds to take care of refugee populations.

- Higher maintenance and replacement costs for harbour and coastal structures affected by increases in sea level and the increased risks of extreme events (flooding from the sea, tropical storms, etc.). Because of increased loading on coastal structures, reinforcement will be required, port facilities will need to be adjusted to the higher sea level, and coastal structures likely will need to be replaced more often.

- Lower agricultural, forestry, and other primary resource production through the loss of productive lands because of sea level rise, warmer temperatures, lower or less predictable precipitation, or a combination of two or more of these climatic changes. The most obvious declines will occur because of losses of productive land in deltaic areas and other lands affected by sea level rise. However, agricultural and forestry losses from warming and precipitation changes will also be significant and probably will affect more regions and countries of the world.

- High costs of production, and therefore lower farm, forestry and other resource net incomes, through the shifting of primary production to less productive soils and less economical sites.

- Decreased fishing production and incomes as a consequence of the shifts in fish migration patterns. At the very least, transitional costs will be incurred—and uncertainty will increase—as fishermen adjust their fishing effort to the new migration patterns.

- Decreased harvests of wild animals, and therefore lower trapping, etc. incomes, through the pressures placed on selected wild animal species.

- Decreased tourism revenues and income through the loss of highly valued coastal tourism attractions and resorts.

- Losses in commercial and residential property values through increases in sea level and other climatic effects.

- Additional economic losses resulting from the "downstream" tertiary impacts of global warming and sea level increase on: human health (mortality and morbidity); loss of valued environment (e.g. recreational beaches); loss of quality of life (e.g. through temperature extremes); and social disruption (e.g. from storm surge disasters).

- Decreased production and/or higher production costs for manufacturing activities dependent on the raw material supplies affected by climatic change. Some facilities may have to shut their doors while others will need to change their sources of supply to more distant—and therefore higher cost—sources of supply.

- Production losses for service activities and non-resource based manufacturing activities influenced by the declines in aggregate demand brought about by the above effects of climatic change (through the multiplier effect) or located in developed urban areas directly affected by sea level rise.

- Costs of relocating people and facilities (tourism, manufacturing, etc.) from locations negatively affected by the rise in sea level and other climatic alterations.

- Additional production decreases through decision-makers adopting strategies designed to minimize risks and maximize flexibility, in place of strategies designed to maximize sales, profits and net economic benefits.

Accordingly, some economic losses will be permanent while other economic costs will be temporary in nature. Permanent losses will result from both production decreases for specific economic activities, as well as higher costs of production, resulting in lower net incomes and GNP, for other activities. Whether the losses are permanent or involve economic costs incurred over a fixed duration, the ultimate consequence is that in 2030 or some other reference year, world GNP will be lower than would otherwise be the case if no climatic changes were to occur. To the extent that climatic change results in shifts from private to public sector investment and therefore higher tax burdens, taxpayers especially in the developed world will experience even sharper decreases in per capita disposable income than in per capita income. This development would run counter to the current trend toward lower taxes and a reduced role for government.

The economic models to properly forecast the actual economic losses have not yet been developed, but the available evidence suggests it would be naive to believe that the losses would be inconsequential. Preliminary work has been conducted on the potential economic effects of climatic change on two countries, Egypt and Bangladesh. These two countries have large deltaic areas which will be negatively affected by the rise in sea level. The results of this preliminary analysis are briefly summarized in Annex A.

As discussed in the Annex, Egypt and Bangladesh may be at the extreme end of the range with respect to production losses. For some countries, especially those in mid and higher latitudes, the negative consequences of climatic change may be offset to some degree by new production opportunities made possible by warmer temperatures, higher rainfall, and improvements in their terms of trade. Canada could be in this second group of countries. Annex B explores the possible consequences of atmospheric change to the Canadian economy. However, it is highly arguable whether any country, or major region within a country, on balance will be left economically better off by the greenhouse effect.

Sectoral Impacts. The scientific data suggests the primary resource sectors (agriculture forestry, fishing and wild animal harvesting) and the primary manufacturing industries dependent on these resources for intermediate inputs, will be the economic activities which are most directly affected by climatic change. These economic impacts will be broadly distributed throughout all multi-country regions of the world. For some countries living close to the margin and highly dependent on these economic sectors, the losses of primary production and net incomes could be nothing short of devastating (see Annex A).

In addition, all economic activities located in urban and rural areas affected by the rise in sea level, will be adversely affected. Other than agriculture and perhaps fishing, the tourism and transportation sectors are the activities placed most at risk by increases in sea level. Coastal locations especially valued by tourists, such as the beaches near Rio de Janeiro, could suffer major losses in tourism revenues. The sectoral impacts of sea level rise will be more location specific and will affect fewer areas; however; the actual losses for specific sectors could be higher and certainly more obvious than the sectoral impacts from other climate induced changes.

Knowledge-intensive manufacturing industries and the service industries, especially the higher order services, are the economic activities likely to be least

influenced by climatic change. These industries tend to be quite footloose, are not tied to sources of raw material supply, and often do not require heavy capital investments. If these activities are located in areas placed at risk by the rise in sea level, they can move to an inland location more easily than the primary sectors and resource dependent manufacturing activities. It should be recognized however that, through inter-industry linkages, multiplier effects, and international economic interdependence, no sector of economic activity will be totally immune from the economic effects of climatic change.

Distribution of Economic Activity. While the effects on aggregate world production will be substantial, atmospheric change will certainly have an even greater impact on the *distribution* of production, GNP, and per capita disposable income among the regions and countries of the world. Because of the anticipated production losses and increases in production cost, comparative advantage and international competitiveness among countries will be altered substantially by climatic change. Countries which now are internationally competitive in the production and sale of a specific primary product or manufactured good may find in the future that they are no longer able to compete in the world market.

If losses in production and efficiency are great enough, some countries will move from being net exporters to net importers of a specific commodity. Countries which are less affected by climatic change may find that, while their production costs may be somewhat higher, their competitive position relative to other suppliers has improved substantially and their exports of a specific commodity have increased.

Climatic change therefore can be expected to have substantial effects on the trading relationships and terms of trade between countries and regions and, through these mechanisms, on the distribution of production and GNP and relative standards of living among countries. For the countries most affected and least successful on implementing adaptation strategies, their balance of payments could be placed under severe pressure and their reliance on outside development finance to satisfy their import requirements and to meet their development goals will increase. Other countries less affected by or more successful in coping with climatic change could experience some improvements to their balance of payments and foreign exchange reserves.

Comparative advantage and international competitiveness among countries are changing all the time, the consequence of shifts in exchange rates, changes in technology, establishment of new production facilities, and discoveries of new resource supplies. Changes brought about through the greenhouse effect will be more gradual than, for example, the alterations resulting from the major realignment of developed country exchange rates which has taken place over the past half decade. Countries therefore will have more time to respond to alterations in their competitive position brought about by climatic change.

In most respects however, the alterations in comparative advantage brought about by climatic changes will be more far-reaching, profound and irreversible than changes brought about by other parameters. National governments and the international community will need to develop appropriate policy responses which address in a realistic way the long-term development potential of each country's economy. Tinkering with

exchange rates and with levels of protection will not be an appropriate response to the fundamental changes in comparative advantage brought about by climatic change

The analysis in support of policy development will need to focus not only on the individual country's development opportunities and constraints but, as well, should realistically evaluate the country's place in the world economy and how its international competitiveness and terms of trade will be affected over the long run by climatic change. Partial economic analysis, which looks at each country in isolation from the rest of the world's economy, will provide inconclusive and misleading results for policy formulation. Sectoral analyses which ignore inter-industry linkages and trade flows offer the same dangers.

Ability to Respond to Climatic Change. The actual economic effects of climatic change on specific countries and regions will depend not only on the country specific magnitudes and rates of atmospheric change brought about by the greenhouse effect. Actual economic effects will depend on a host of other economic and social variables which when combined together dictate how a country responds to an external shock. Actual economic effects on specific countries and regions will depend on the following set of factors (partial listing only):

1. Magnitude and rate of climatic change relevant to a specific region or country.

2. Area of land placed at risk by sea level rise.

3. Importance to the economy of the primary and other economic activities which will be most directly affected by climatic change.

4. Diversification of the country's economy and the importance of knowledge intensive industry and related service activities. Other things being equal, a country with a more diverse economy is more likely to possess a mix of both "winning" and "losing" sectors and will be in a better position to transfer productive resources into alternative sectors of activity .

5. Strength and maturity of the country's business, labor, political and social institutions.

6. Country's balance of payments position, debt load, foreign exchange reserves and access to international financial markets.

7. Budgetary position of the national government (and of state/provincial governments in a federation).

8. Level of education of the work force and the country's scientific base, technological development, and research and development capabilities .

9. Country's experience with previous external shocks.

As a general statement, developed countries will be able to respond more effectively than developing countries to the economic effects of climatic change. In many instances, developed countries may be less directly affected by warming, precipitation

changes, and sea level rise, and for some in the mid-to high latitudes climatic change could involve a mix of positive and negative economic consequences. The developed world generally is less dependent on the economic sectors which will be most directly affected by climatic change. Developed countries potentially have the financial resources, educational and technological base, and political and institutional maturity, to cope with the economic impacts and social dislocations brought about by atmospheric change, and are in a better position to compensate their residents who suffer especially large economic losses from the greenhouse effect.

Experience with external shocks suggests there may be some qualifications to this general statement. Canada, for example, responded to the first two oil crises by attempting to shield its consumers from the full price effects. As a consequence, Canada realized fewer efficiencies in fossil fuel consumption than any other developed country and probably has been left more vulnerable to the next round of oil price increases (because the required structural adjustments have only partially taken place).

To provide a second example, the green revolution in agriculture has resulted in substantial improvements to the food production capabilities of may developing countries and significant declines in international trade in farm products. India and Pakistan for example which traditionally have been net importers of food are now largely self-sufficient in foodstuffs. The response of the European Community, followed by the United States, Canada and other major agricultural producers, has been to maintain farm production and incomes through expanded subsidies to the farm sector. The resulting over-supply of food products hurts producers in both the developed and developing world.

On the other hand, the Republic of Korea, Taiwan, Singapore and other newly industrializing countries (NIC's), have successfully absorbed massive changes to their economic, social and technological structures in a very brief period of time. The lessons learned from their recent successes, combined with their highly diversified economies, strong technological base, and high levels of education, should help the NIC's to effectively cope with the economic effects of climatic change.

The scientific and economic research on the greenhouse effect is not sufficiently advanced to identify the countries which will be most and least affected by climatic change. However, unless effective limitation and adaptation strategies are implemented by national governments and the international community, climatic change can be expected to :

- Increase per capita income disparities between the developed and developing worlds.
- Further heighten the growing income differentials within the developing world between the NIC's and the least developed countries (Bangladesh, the countries of Sub-Saharan Africa, etc.).
- Exacerbate the international debt crisis.

- Heighten income disparities between developed countries and among regions within developed countries

In short, without effective policy interventions, the greenhouse effect will likely leave us with a less equal and therefore more dangerous world.

Effects on Human Settlements. The increase in sea level and other climatic changes resulting from the greenhouse effect may significantly reduce the amount of usable land available to agriculture and other land intensive economic activities. As a consequence, substantial, perhaps unprecedented, numbers of people will need to be relocated.

Some of the least developed countries that are most affected by climatic change, and least able to cope with its effects, may not be able to contain this migration within their borders. Climatic change therefore could add substantially to the world's refugee populations. These refugee populations will place major stress on the financial and economic resources of host countries and the international community, could cause social an economic dislocations in the host countries, and could lead to border and other political problems between the host and source countries. These problems could be exaggerated in instances where the host country or region is not significantly better off than the source country of the refugees, (for example, West Bengal in India *vis-à-vis* Bangladesh).

Unless a city is directly affected by sea level rise, its economic activities likely will be less at risk from climatic change than economic activities carried out in the surrounding rural ares. Therefore, for countries which are able to contain migration within their borders, most of the rural people displaced by the economic effects of climatic change will flock to the major cities in search of employment and security. Climatic change therefore will add to the already very difficult conditions in the major urban centers of the developing world. Even now, standards of living, education, health, sanitation and transportation in most Third World cities are well below minimum acceptable norms, and few city governments in the developing world have the power, resources and trained personnel to meet their residents' basic needs. The urban crisis after climatic change could be even more intractable.

Effects on Commodity Markets. Scientific evidence suggests that the greenhouse effect will result in a drop in agricultural production. The decline will reflect the loss of arable land to sea level rise, greater variability and the less predictability in the weather (temperature and precipitation), the shifting of agricultural production to less fertile soils, and higher farm production costs. Given the current oversupply of food, the greenhouse effect could result in expanded trade in farm products, some strengthening in agricultural prices and, other things being equal, increases in net income for farmers and agricultural regions which are less directly affected by climatic change. However, other things may not be equal to the extent that climatic change likely will result in higher farm production costs. The latter outcome could reflect the need to adopt new varieties which require more intensive farm management practices, as well as higher farm input costs resulting in part from higher transportation costs. Climatic

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changes will affect some farmers and agricultural regions more than others, but whether any agricultural region will be better off in a an absolute sense is problematic.

Climatic change will have mixed effects on the production of and markets for non-farm commodities. In the case of forest products, unless the rate of change is more gradual than anticipated, some loss of forestry production from the mid-latitude regions appears to be inevitable, since changing climatic ranges will not be matched by suitable soil conditions.

Production of mineral products would decline to the extent that mines and other production facilities operating near the coast are made non-viable because of the rise in sea level. These losses however could be offset by the opening up of new mines in high latitudes which are made economically viable by changes in transportation routes and economics brought about by decreases in the Arctic pack ice. To cite another example of potentially offsetting forces, higher temperatures and the reduction of sea-ice could facilitate off-shore oil and gas development in Canada's Arctic. At the same time, higher temperatures and sea level rise could make on-shore oil and gas development in the Canadian Arctic more difficult. Because of these potentially counteracting forces, the net effect of climatic change on mineral production is not obvious at this time.

However, in light of the overall downward effect of climatic change on world GNP and therefore on industrial demands for non-farm commodities, climatic change could result in further downward pressure on non-farm commodity markets and prices. This downward pressure could be further exaggerated if national governments respond to the greater political uncertainties and risks by developing their own sources of supply for strategic non-economic reasons. Producer returns could be further pinched if climatic change results in higher transportation costs and costs of capital. In short, climatic change likely will not provide a panacea for the current slump, historically low prices and unfavourable longer-term prospects in commodity markets.

Effects on Financial Markets and Investments Patterns. Based on past experience, the world's financial markets can be expected to cope with the economic forces brought into play by climatic change in the sense that market prices for capital will continue to be established and investment funds will continue to be allocated to investors, sectors of economic activity and countries.

The methods of response however could lead to sub-optimal patterns of investment throughout the world. Atmospheric change, and the uncertainties associated with its magnitude and rate of change, will provide an additional measure of risk to any investment and therefore will result in higher costs of capital and interest rates. Investors do not like uncertainty and therefore will tend to shy away from investments, sectors and countries which are perceived to be most at risk from climatic change. For example, private investments in deltaic areas at risk from sea level rise likely could be restricted to activities which offer quick returns and short pay-back periods. Real estate investments, which hold the potential for quick turn over, may still be attractive for some time. However, private investments in manufacturing and other employment generating activities with longer gestation periods likely will be minimal.

Sea level rise and other effects of climatic change will require governments to make massive investments in dikes, harbour facilities and other infrastructure. These public sector requirements will siphon investment capital away from other economic activities, thereby further increasing the cost of capital to those activities..

Developed countries and their governments have the financial resources and tax base to finance the non-revenue generating infrastructure investments made necessary by climatic change. Most developing countries, especially those which already have high debt burdens, do not have the required financial resources and access to international capital. Development finance from bilateral and multilateral donors will need to make up the shortfall in investment funds. This however runs against trends in development finance. Financial assistance to developing countries has shown no growth in recent years and many donors have been emphasizing revenue generating private sector type investments, over public infrastructure investments, in their development programs and aid packages.

In short, climatic change could hold the following implications for financial markets and investment patterns:

- higher interest rates and costs of capital
- sharply reduced investment flows into areas perceived to be at risk.
- reallocation of investment capital in developed countries from private to public sector investments
- shifts in investment capital from developing to developed countries
- further reduction in developing countries' access to investment capital on the international market.

Unless effective adaptation policies are implemented and the international debt crisis is successfully addressed within the context of climatic change and related environmental forces, the greenhouse effect will accentuate other trends which are preventing developing countries from attracting the investment capital they need to meet their development requirements.

Uncertainty, Risk and Decision-Making. Climatic change will have a substantial effect on the decisions made and the way decisions are formulated by business people, government officials, farmers, fishermen, and other primary producers. Climatic change will add another significant element of risk to the various risk factors business people must now consider in making decisions on where to sell, locate and invest. Business people already face a high-risk environment caused by major and often unpredictable fluctuations in exchange rates, interest rates, inflation, stock market prices, energy and other commodity prices, and market demands. The international debt crisis, the large fiscal deficits of Canada, the United States and other western governments, changes in governments and their policy directions, shifting attitudes towards the environment and environmental regulation, among many other political factors, augment this climate of uncertainty. After more than a decade of oil crises,

abrupt shifts in economic policies, the debt crisis and so on, many business people projected, or at least hoped for, a more stable and certain decision -making climate in the 1990s and into the next century. This appears less certain today, especially in light of atmosphere change and its projected economic impacts.

Business people therefore could become increasingly risk-averse, and may place growing emphasis on taking over existing businesses rather than investing in new businesses. Compared to new business ventures, takeovers take less time, can now be readily financed through somebody else's money, and typically involve fewer risks. Accordingly, atmospheric change, when added to all the other risk factors, could accelerate the long-term upward trend in takeover activity in western world, and result in longer and more intense merger waves. Political and public concerns regarding takeovers and their socio-economic effects would be further heightened.

Increased risk and uncertainty, combined with decreases in aggregate production and major shifts in trade, will expand the number of bankruptcies and the pressures on western governments to ameliorate the negative effects of bankruptcies on small shareholders, employees, suppliers and creditors. The risk of bankruptcy could particularly increase for smaller business and businesses in less prosperous regions. These businesses typically lack the financial resources, alternative market opportunities and in-house technical and management expertise to adapt to dramatic shifts in their external environment.

Governments also will be facing a more uncertain world in formulating their short- to medium-term expenditure and revenue projections, in preparing economic, social and other programs, and in developing and implementing their capital investment programs. Like businesses, governments may be forced to become more risk-averse and perhaps could become less innovative in their decision-making. Overwhelmed by these risks and the amount of information and consultation needed to develop new policy directions, governments may tend to hold on to out-dated policies and programs longer than they should. The alternative danger is that governments will adopt new policy directions without taking full account of all the risk and other factors which influence policy decisions and their socio-economic effects. As a consequence, new government programs could have impacts totally contrary to their intended effects.

The decisions of farmers will also be affected by the high-risk environment. Precipitation and temperatures will be less predictable, and market prices and the costs of inputs also could experience greater year-to-year fluctuations.

Farmers, especially farmers in the Third World, will be more reluctant to make major investments in their farms, and to adopt more intensive farm management practices. The result could be even greater decreases in world agricultural production and in food security in the Third World. These decreases will be above and beyond those directly attributable to climatic change.

Fishermen, foresters and other primary producers will also face greater risks and uncertainties. Changing fish migration patterns will mean that fishermen will need to substantially alter their fishing effort in ways which are difficult to determine now and

could be difficult to determine on a year-to-year basis in the future. Foresters will need to adjust their harvesting techniques and activities in relation to changes in forest productivity and to latitutional changes in forest cover. Warmer temperatures and lower precipitation also will increase the risks of forest fires and the number of areas at risk from pests.

The greater risks and uncertainties caused by climatic change will force decision-makers to become more flexible and adaptive in preparing and implementing plans, policies and programs. Strategies designed to maximize sales, profits or economic benefits may need to be replaced with strategies designed to maximize flexibility and minimize risk. Climatic change may force decision-makers not only to make different decisions but also to make decisions and approach problems in a different manner. Probability modelling, risk analysis and simulation modelling, could replace optimization techniques, when business people, primary producers and governments make decisions on where, when and how to invest, locate, produce and sell.

Effects on Transportation. Climatic change will have mixed effects on transportation economics. Reductions of sea-ice in high latitudes and other developments could open up new low-cost transportation routes (e.g. the Northeast and Northwest passages in the Arctic) and increase the transportation alternatives available to shippers. On the other hand, in coastal areas directly affected by sea level rise, harbour facilities will need to be rebuilt and on-going maintenance costs will be substantial. The latter effects are more obvious at this time and could more than offset the improved competition and the economies resulting from new transportation routes. The overall effect therefore could increase transportation costs to producers and consumers. Overall effects on transportation cannot be estimated at this time, but their implications for specific national economies and international trade could be among the most important long-term impacts of climatic change.

Effects on Technology and Research and Development. Climatic change will provide new challenges and opportunities to the scientific community. Existing technologies will need to be carefully evaluated for their relevance to a changing world and their potential to mitigate the climatic and economic impacts of the greenhouse effect. Research and development funds will need to be reallocated to identify new agricultural varieties which will be more responsive to the climate of the next century, and to support research on the forest species and forest management practices needed in light of changing climatic conditions. Diffusion of technological advances to the countries and sectors most affected by climatic change will be critical . The monopoly rights provided by traditional intellectual property laws and practices may need to be modified to ensure access to technology by all affected countries, sectors and socio-economic groups.

Consumer Prices. Atmospheric change can be expected to have significant effects on the demand for and supply of internationally traded goods and therefore ultimately on consumer prices. There will be pressure on governments to raise the prices of fossil fuels—through import taxes or taxes at the pump—in order to: reduce fossil fuel use; increase consumption of alternative fuels; and perhaps help finance the research, development and transfer of alternative energy technologies, and projects designed to mitigate the effects of climatic change on less developed countries. Despite research and

development efforts, energy from alternative technologies (wind, solar, tidal, etc.) inevitably will be higher priced than energy from fossil fuels. Changes in the energy mix will further increase the price of energy to consumers.

Goods with a heavy transportation component or whose production, transportation and distribution are affected by the rise in sea level, could also experience quite significant price increase. To the extent that sea level rise reduces the supply of tourism facilities and forces operators to relocate their facilities inland at considerable cost, demands for the remaining coastal facilities which are not affected will increase and the cost of the family vacation will rise. To the extent that decreases in agricultural, forestry and fishing production exceed the anticipated decreases in per capita disposable income, the consumer prices for food stuffs and forestry products can also be expected to advance.

The available evidence suggests therefore that the prices for many basic products in the household budget and critical intermediate inputs for the industry could increase significantly because of the effects of atmospheric change. Western governments could come under pressure to protect lower income groups, major industries and "special interests" from the full price effects of climatic change.

Health Effects. Atmospheric change and related environmental changes, such as depletion of the ozone layer and acid rain, are expected to have serious effects on human health. These effects in turn will negatively influence: human mortality; work attendance; labour productivity, innovation and entrepreneurship; and ultimately aggregate world production and per capita incomes. Health research has identified the comfort zone which establishes the temperature range within which human populations can live and flourish. Very high or very low temperatures can negatively affect social behaviour and many human functions. Research has shown for example that, after a certain optimum temperature has been passed, labour productivity decreases substantially with each increase in temperature, especially when humidity is high. Atmospheric change will clearly move us above the comfort zone more often. The health and productivity effects in regions not accustomed to extremely high temperatures could be particularly serious.

Incidence of disease could also increase. Increased precipitation and ground water combined with seasonal temperature extremes could significantly influence the breeding conditions, growth rates and numbers of many species including parasites which affect human populations. Depletion of upper level ozones combined with higher temperatures and more cloud free days will substantially expand the risks of skin cancer for light-skinned people in higher latitudes. More frequent storm surges will add to the health effects and increased mortality rates caused by climatic change. The health and mortality consequences of changes to the climate will depend not only on the impacts themselves but also on the will and resources of governments to address these health concerns. To the extent that climatic change reduces world production and incomes, the financial resources available to address human health problems could also diminish substantially, especially in the least-developed countries where the incidence of disease and mortality rates are already high and health care resources are stretched to the limit. Therefore, without appropriate adaptation strategies, the health consequences of the

greenhouse effect will seriously exacerbate the losses in aggregate production and increases in income disparities caused by other socio-economic forces.

Implications of the "Surprise" Climatic Scenarios. The analysis in this section has largely addressed the relatively gradual, surprise-free scenarios of the greenhouse effect. Little attention has been given to the catastrophic effects of the "surprise" scenarios which for example could result in sea level increases in the range of 20 to 30 metres in a comparatively short period. If they were to occur, sea level rises of this magnitude would have devastating effects on the country economies and populations most directly affected, and very disruptive impacts on world industry, trade, and investment patterns.

Even if these catastrophic events do not take place, the climatic and economic uncertainties, combined with the very high risks associated with the surprise scenarios, can be expected to have significant effects on financial markets and the flow of investment funds, especially if the surprise scenarios and their potentially devastating impacts become the focus of international media attention. The consequences would be higher costs of capital, higher interest rates and even greater distortions in investment patterns, than are anticipated from the surprise-free scenarios.

Financial markets are adaptable over the long haul but, as October 1987 points out, are prone to over-respond to external shocks in the short- to medium-term. Adaptation strategies will need to address the surprise scenarios and their potentially disruptive effects on financial and other markets, and on business and government decision-making.

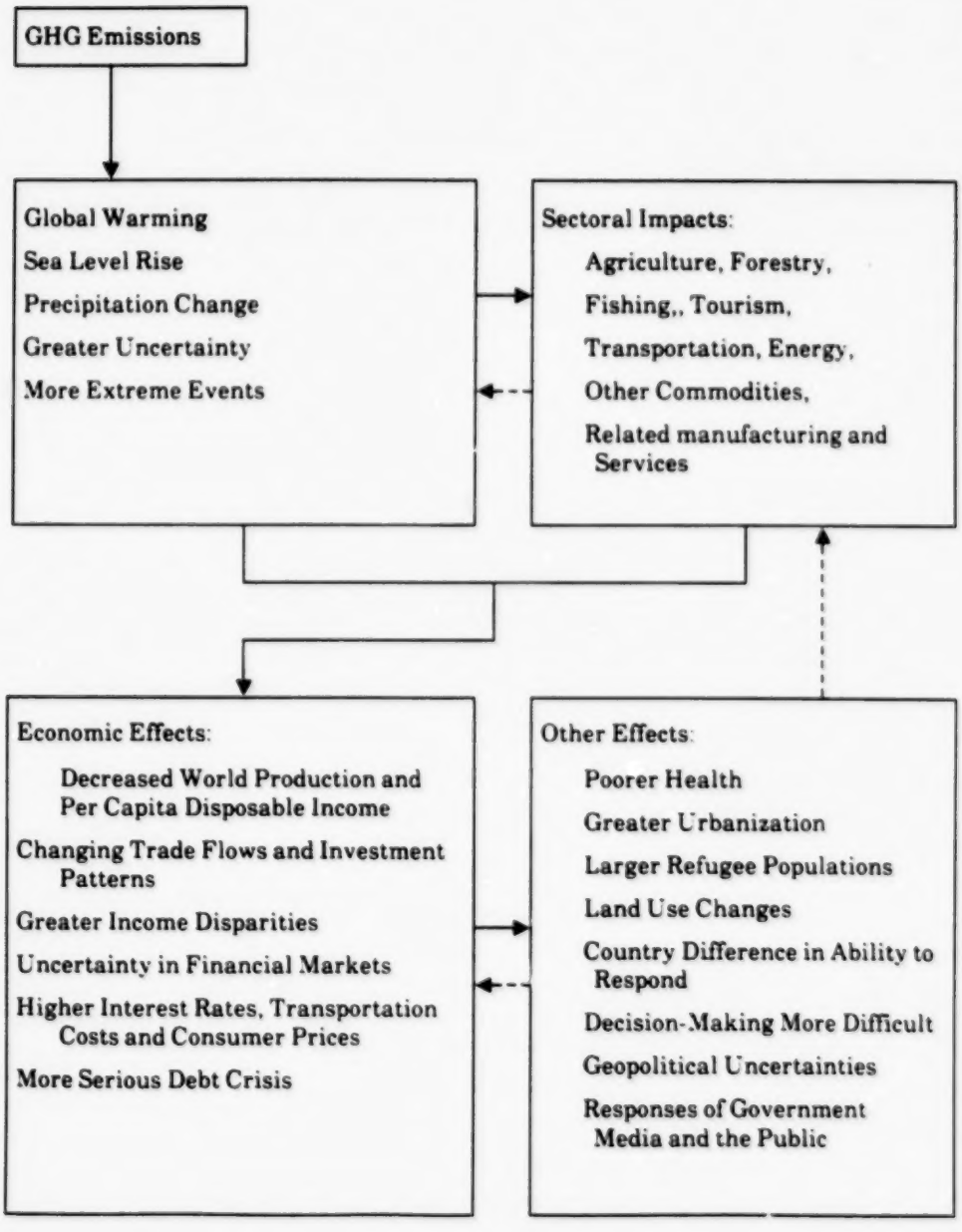
Relationship to Current Government Policies. One potential benefit from the greenhouse effect is that national governments may be forced to re-evaluate and alter development and other policies which are of dubious validity for other reasons. Developing countries that are attempting to achieve food self-sufficiency with marginal agricultural resources may be forced to consider alternative development policies which involve a more economic use of their labour, capital and entrepreneurship. Other developing countries which emphasize export crops at the expense of small-holder production may be forced to change their agricultural priorities in favour of farm production to satisfy domestic nutritional requirements.

Changes in comparative advantage may force developed countries to alter their farm subsidy policies which currently encourage over-production and the misallocation of productive resources. Developed countries, through recognizing the dramatic effects of climatic change on the developing world, could make appropriate modifications to their tariff and non-tariff barriers, their immigration policies, and their allocations of official development assistance to the Third World. Climatic change, when added to all of the other arguments, may force governments and the public to recognize the full dangers of fossil fuel consumption, chlorofluorocarbons, and deforestation. Finally, atmospheric change and its global economic consequences, may result in renewed support and commitment to the international institutions established to address global problems.

The above can be criticized as wishful thinking. However, because the greenhouse effect is irreversible and global in its effects, arguments based on climatic change may have greater force than other arguments in favour of more rational economic and environmental decision-making.

Climatic Change and Global Trends. With few exemptions, the climatic changes brought about by the greenhouse effect will tend to heighten some of the more negative features of the global trends discussed in Chapter Three. Global trends likely to be accentuated include: the growth in urbanization in the Third World; expanding refugee populations; income disparities between the rich and the poor; instability and uncertainty in international financial and commodity markets; and the shortfalls in development assistance available to the Third World. There are no obvious areas where climatic change will mitigate the more negative consequences of global trends or where global developments will help to offset the more negative consequences of the greenhouse effect. Without well-designed and implemented limitation and adaptation strategies, the greenhouse effect and climatic change will add to the world's inequalities, instability and insecurity.

Exhibit I
Climatic Change and the Economy: Interrelationships and Feedbacks



5. Possible Responses of National Governments and the International Community

Mitigating the economic impacts of atmospheric change will require a judicious mix of limitation and adaptation strategies. However, the development and implementation of strategies must be guided by a full appreciation of: the complexity of the processes brought into play by climatic change; of the relationships and interactions among the greenhouse gases and between the greenhouse effect and other environmental developments; of the linkages and feedback relationships between the critical economic and environmental variables; and of the relevant inter-industry and inter-country linkages. Exhibit I attempts in simplified form to portray some of the relationships and feedback loops. Unless a holistic or "general equilibration" approach is employed in research and strategy formulation, strategies could easily have conflicting objectives and generate impacts which are perverse, counter-intuitive and totally contrary to the effects anticipated by planners.

Limitation strategies to reduce fossil fuel consumption and the rate of deforestation must be based on a realistic appraisal of the economic forces which govern these processes. Using Canada's experience as a guide, advertising and moral suasion on their own will not reduce fossil fuel consumption. The price system must be allowed to operate, through higher import or production taxes or higher retail taxes at the pump. If higher oil and gas prices have adverse effects for lower-income groups or selected economic sectors, these adverse effects should be mitigated through more generalized interventions to shield all consumers from the effects of price increases. This lesson from Canada's recent past can be a useful general guide for strategy formulation in response to climatic change.

Encouragement of alternative fuel production and consumption will require substantial R&D expenditures by government. Increased R&D expenditures on the nuclear alternative and on methods to reduce the risks of nuclear technology will need to be supplemented by public information campaigns to inform the public of the risks of nuclear fuels compared to the risks and climatic/economic effects of further growth in fossil fuel consumption. Hydroelectricity generation offers another alternative fuel. However, hydro strategies must take account of the changes in precipitation patterns resulting from the greenhouse effect and the danger that hydrodams will reduce sedimentation in downstream deltaic areas. The socio-economic problems often associated with major hydro construction projects will also need to be addressed.

Efforts to reduce the rate of deforestation in Brazil, Nigeria, Indonesia, etc. must take full account of their development goals and opportunities and of their development goals and opportunities and of the burdens placed on these countries by debt repayments. Programs which attempt to reduce deforestation without addressing their international debts and overall development needs are doomed to failure. A comprehensive development approach is clearly required for these countries.

While limitation strategies should and must play a role, adaptation strategies are also needed to mitigate the economic effects of climatic change. Even if fossil fuel consumption and the rate of deforestation are substantially reduced in the near term, the earth will continue to warm, although at a reduced rate, for many years into the future. The build-up of carbon dioxide and other greenhouse gases which has already occurred in the atmosphere makes the greenhouse effect inevitable.

The following provides a very preliminary listing of the adaptation strategies which could be considered by national governments and the international community in order to mitigate the economic effects of climatic change.

1. Scientific research and modelling on climatic change should give priority to: reducing the uncertainties, error bounds and wide ranges associated with global warming and sea level rise estimates; better forecasting the effects on precipitation globally and by region; better modelling and forecasting the regional and country specific implications of climatic change (which will require both latitudinal and longitudinal models); better identifying the interactions and relationships among the greenhouse gases and effects and between the greenhouse effects and other environmental trends; identifying the developing and developed countries, and regions within countries,which are most vulnerable to atmospheric change; and evaluating the probability and likely consequences of the surprise scenarios for climatic change. Reducing the current uncertainty surrounding climatic change estimates is essential for the development of an international consensus and commitment to effective policy responses.

2. Economic research should be directed towards developing economic methods and models to forecast the economic consequences of the greenhouse effect for the international economy and for multi-country regions, countries, and regions within countries. Economic methods should include both economic impact models, which project the effects for GNP, employment, sectoral production, etc., and

economic benefit-cost models which evaluate the implications for economic welfare and efficiency for specific countries and the world as a whole.

In applying benefit-cost methods, the research should consider whether standard discounting techniques, which typically involve discount rates of 10 per cent or more, are appropriate to the appraisal of climatic and economic events which will have serious consequences 30 to 50 years into the future. As well, modifications may be needed to ensure that environmental and other externalities, as well as effects on income distribution within and between countries, are fully addressed in the benefit-cost analysis.

The macroeconomic analysis proposed here should be supplemented by detailed sector specific studies on the effects of climatic change on production, trade, and the locations for production. First priority in the sector analysis should be given to the primary sectors most directly affected: agriculture, forestry, fishing, energy, other commodities and transportation, but over time the research should be expanded to include all sectors of economic activity. Sectoral research, while focussing on one sector, should not ignore inter-industry linkages and dependencies.

4. Socio-economic and institutional research should be conducted on the factors and forces which dictate whether a country responds effectively or unsuccessfully to the pressures and uncertainties caused by the climatic and economic changes of the greenhouse effect. One information source for this research is the past response of countries to external shocks such as the recent oil crises and the rapid and dramatic changes in exchange rates. The economic research proposed under (2) to (4) should move ahead now. The research must not be delayed pending improved scientific models and forecasts..

5. Information dissemination strategies are needed to ensure that business people, labour unions, national governments, international institutions, and the public at large, are working from the same information base in making decisions related to climatic change and its economic effects. The common information base can then be used to develop an international consensus around the climatic and economic consequences of the greenhouse effect. In the absence of an effective information program, international consensus is unlikely .

6. Information strategies are also needed to ensure that governments, business people, and non-government organizations are aware of the most current technologies relevant to limiting the effects of or adapting to climatic change. An international agency such as WIPO (the World Intellectual Property Organization under the UN) could implement this strategy through providing a central depository and clearing-house for information on technologies relevant to climatic change.

7. Consensus building and decision-making could be facilitated through preparing a set of long-term environmental targets relating to the rates of temperature and sea-level change. However, to be believed and used by decision-makers, the environmental targets should be based on the best scientific evidence available

and on a realistic appraisal of the ability of national governments and international institutions to respond effectively to the challenges posed by atmospheric change. Unrealistic targets which set goals that cannot be achieved would not be helpful and would tend to discredit the reliable scientific evidence already developed on climatic change.

8. For countries most vulnerable to atmospheric change, the greenhouse effect and its climatic and economic consequences should become an integral part of the formulation of development plans by national governments and international institutions, and should become an integral component of the aid programs and packages of donors.

9. For other countries, their current development policies and programs should be evaluated in light of the known climatic and economic impacts of the greenhouse effect. Particular emphasis in the policy review process should be placed on agricultural policies, energy policies, immigration, and the tariff and non-tariff barriers to imports from developed countries.

10. Special development strategies are needed for the coastal areas which are most at risk from the rise in sea level. Depending on the area, appropriate strategies could include: dike and related construction to protect the land and populations at risk; identifying areas which cannot be helped by diking and other protective measures; adopting appropriate investment strategies for those areas; labour force retraining programs; and relocation strategies for people and production facilities.

    Appropriate investment strategies likely would be designed to discourage long-term investments which would entail a needless waste of capital, and to encourage shorter-term, maintenance-type investments needed to maintain living standards and the quality of life of the area's residents over the short- to medium-term.

    Planning for affected coastal areas should be based on a sound appraisal of the long-term economic and social needs of the coastal area's inhabitants and the country as a whole. For coastal areas with popular tourism facilities, there is the danger that the resorts will receive most attention and financial resources (in part to preserve the flows of foreign exchange provided by the resort). If financial resources are scarce, this attention could be at the expense of other critical public needs, such as the economic and social requirements of affected local inhabitants.

11. The monopoly rights traditionally provided by intellectual property laws and practices may need to be modified to ensure maximum access to the technologies required to mitigate the climatic and economic impacts of the greenhouse effect. Alternative means may need to be found to ensure that inventors and innovators receive proper compensation for their creative efforts. In addition, in order to supplement current IP statutes and international agreements, the development programs of aid donors may need to give increasing weight to: technology access and transfer; financial and technical assistance to developing countries to assist them in establishing their own IP regimes needed to encourage the generation of appropriate indigenous technologies; and direct financial assistance to partially or

fully offset the high costs of importing the new technologies required to mitigate the effects of climatic change.

12. In implementing limitation and adaptation strategies, more relaxed rules should be applied to the least developed countries compared to the developed world and the NICs. Different rules are needed for reasons of fairness–most of the present problem has been caused by the developed countries–and to take account of: the limited financial resources and adaptability of many developing countries; and their more limited options in terms of utilizing alternative fuels.

13. The greenhouse effect is a global problem and no country will be totally shielded from its consequences. At the same time, some countries will be affected more adversely than others. Current evidence indicates that the nations most at risk include some of the least developed countries in the world. Adaptation strategies therefore should include measures by which the countries that stand to lose the least from climatic change compensate the countries which experience the greatest economic losses.

    One response is to substantially increase the official development assistance available from bilateral and multilateral donors. Other responses could include: substantially reducing the tariff and non-tariff barriers placed by OECD countries on products from developing countries; changes in the immigration policies of developed countries; and having the developed countries shoulder virtually all of the costs of the research, development, and technology development and diffusion needed to effectively respond to climatic change.

14. Climatic change is a long-term problem and therefore may not receive the attention warranted from politicians, the media and the public. Awareness of the greenhouse effect can be heightened, and limitation and adaptation strategies could begin implementation in the near term, through linking climatic change to more immediate policy concerns related to acid rain, depletion of the ozone layer, afforestation, agricultural subsidy programs, food security in developing countries, the international debt crisis, and other more immediate issues. The development of strong linkages will both provide a foundation to begin implementation of climatic change strategies, and will give a longer term economic and environmental perspective to more immediate policy initiatives.

Limitation and adaptation strategies should be formulated and implemented with full recognition of the obstacles to their effective implementation. These include:

- the limited planning horizon of most governments (elected an non-elected)
- limited public knowledge and understanding of the effects and risks of climatic change
- public concerns regarding the risks of nuclear technology, and the adverse socio-economic impacts of other alternative fuels such as hydro

- the legitimate demands of developing countries to enjoy a better standard of living and to approach developed world standards of consumption, including fuel consumption and use of refrigeration
- problems encountered by decison-makers (private and public) in adopting an overall, comprehensive and integrated view of environmental and economic issues
- the substantial demands of other spending priorities of government, in particular the financial needs of the military as well as the spending requirements of domestic social programs
- recent trends toward lower taxes and a reduced role for government
- the potential effectiveness of lobby groups representing interests (such as the oil and gas industry and coal companies) which would be adversely affected by limitation and adaptation strategies.

This paper in a preliminary manner has attempted to address some of the means available to address these obstacles. Other policy responses doubtless will flow out of the discussions at the Industry, Trade and Investment workshop and at the Conference itself.

Annex A:

Economic Effects of Climatic Change on Egypt and Bangladesh: A Preliminary Analysis*

Preliminary work has been conducted on the potential economic effects of climatic change on two countries, Egypt and Bangladesh. These two countries have large deltaic areas which will be negatively affected by the rise in sea level. In Egypt, the analysis indicated that the area to be inundated by a one metre rise in sea level would comprise about 12-15% of the nation's arable land and about 16% of Egypt's population of 49 million. The area that could be lost to the sea from a 3 metre rise in sea level would contain about 20% of Egypt's arable land and about 21% of its population. Based on the assumptions employed in the analysis, corresponding declines in Egypt's gross national product are expected to result from the projected increases in sea level.

Using similar assumptions, the analysis found that a one meter rise in sea level would result in an eight percent drop in Bangladesh's GNP, and a three meter rise would lead to a 20% decrease. The affected population in the high scenario would have been 25 million people based on 1985 data, and given the country's high population growth rate would be substantially higher when the full effects of sea level increase are realized. Other negative consequences for Bangladesh, consequences which were not factored into the above calculations, are:

- the population at risk from storm surge would rise dramatically; the area at risk from a three metre rise would include the capital city of Dhaka;

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* This Annex is summarized from James Broadus *et al.*, *Rising Sea Level and Damming of Rivers: Possible Effects in Egypt and Bangladesh*.

- agricultural productivity could be significantly decreased by the intrusion of salt water into the nation's fresh ground water resources;
- the effects of sea level increase on Bangladesh's deltaic areas would be greatly expanded if dams and other water works upstream substantially reduce the delivery of sediments to the delta.

Bangladesh, with per capita income of about $140 per annum, is living close to the margin of survival at the present time. Any further economic setbacks caused by atmospheric changes could have devastating effects on the standard of living and quality of life in the country.

Annex B:

Consequences of the Greenhouse Effect for Canada*

Canada has been cited as a potential beneficiary of the greenhouse effect and perhaps as one of the few countries which will experience a net increase in national income as a consequence of atmospheric change. Anybody who has suffered through a long cold Canadian winter will be heartened by the potential for shorter winters, longer springs and falls, and gloriously warm long summers. However, before gloating becomes a national fetish, Canadians should perhaps take a closer look at the evidence. The available evidence indicates that the positive impacts of climatic change for certain sectors could be offset by negative impacts in the very same sector and that Canada will face some other very serious consequences of climatic change which appear to have no positive offsets.

It should be noted at the outset that most of Canada lies in the high latitude region above 60°N, the region which will experience the most extreme change in weather as a consequence of climatic change. Increases in temperature for example could be up to 2.4 times greater than global averages. As well, the high latitude regions could experience increased cloudiness and precipitation; summer pack-ice in the Arctic could disappear; and Arctic permafrost could slowly become a thing of the past. By far the greatest changes in high latitudes will occur in the winter months. The situation will not be markedly different for the vast majority of Canadians who live near the American border. The mid-latitude regions will also experience greater temperature increases than the

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* This Annex is largely drawn from two sources: Dr. Fen Hampson and Ken Bush, *Changing Atmosphere: The Problem From a Canadian Perspective*; and an article on the Canadian impacts of climatic change which appeared in the July 2-4 edition of the *Financial Post*. The *Financial Post* used a variety of Department of Environment reports in preparing its article.

global average warming. However, precipitation in summer could decrease and soil moisture in summer could further decline because of enhanced evapo-transpiration with the increase in temperature. The scientific evidence suggests that the main impacts in the mid-latitudes are expected to be on relatively unmanaged ecosystems.

Examples of offsetting sectoral impacts which could be experienced by Canada because of climatic change are discussed in the next several paragraphs.

Agricultural production will become feasible in more northerly locations. For example, Northern Ontario would be able to support production of wheat, soybean, corn and canola crops.

However, soil conditions in many northern areas will limit crop choice and productivity, and northern farms are further from markets and major transportation corridors and therefore will have to absorb higher transportation costs. As well, grain-producing areas in the southern Prairies would be more vulnerable to frequent periods of drought.

Other things being equal, climatic change could allow the Fraser Valley of British Columbia, the Niagara region of Ontario, and the Annapolis Valley of Nova Scotia to become three of the most productive and profitable farming regions in North America. However, much of this highly productive farmland is being lost to urban development. Once climatic change has reached its full impact, the farming option for Canada's richest farmland may have been essentially foreclosed.

Warmer temperatures will mean lower energy demands in winter,and small demand increases in summer because of increased use of air conditioning. Increased ice-melt in the north could raise Canada's hydro-electric capacity. To the extent that the technological risks and the waste disposal problems are successfully addressed, the nuclear option could make a comeback, providing expanded markets for Canada's Candu technology, uranium and heavy water.

Canada however has the highest rate of energy consumption in the world, and experienced the least adjustment in energy consumption patterns from the 1970s oil crises, the consequence of government efforts to shield consumers and industry from their full price effects. Canadian consumers and industry therefore will be under intense pressure to use energy more efficiently, to switch to alternative higher cost fuels, and to reduce overall energy demands. Adjustment in Canada will be more difficult than in other countries because so little adjustment took place over the past two decades. As well, lower water levels and mean flows in the Great Lakes could lead to losses in hydro-electric power generation from that source.

Warmer temperatures will extend the tourist season of summer resort operators and could significantly increase the attractiveness and financial feasibility of tourism destinations in Canada's more northerly regions. However, ski operators will face a shortened ski season and less predictable snow conditions, placing at considerable risk the major investments made recently in Canada's international ski resorts such as at Whistler, British Columbia. As well, reduced rainfall and its effects on marshlands and

other wildlife habitat will reduce hunting and fishing opportunities in many areas, particularly in the Prairies.

Many of the effects on Canada's transportation sector could be positive. Great Lakes ice cover could disappear, thus extending the shipping season. Reduced pack-ice could extend the shipping season in the Canadian Arctic. Warmer winter temperatures and reduced snowfall should reduce inland transportation costs for truckers and railroads. Airlines could experience fewer disruptions because of winter storms.

However, Great Lakes water levels are expected to fall considerably, cutting ships' cargo capacity and raising the operating costs of Canada's Great Lakes shipping companies. Rising sea levels will have the same effects in Canada as elsewhere. Coastal shippers would be forced to relocate or raise their wharves, maintenance cost for coastal facilities will be substantially higher, and dikes and other protective works will need to be constructed to protect coastal areas.

The longer shipping season could significantly enhance the financial feasibility of mineral, oil and gas and other resource production in Canada's north. With proper planning, the economic benefits to Canada's northern residents could be substantial. However, the favorable economic effects could be offset by the long-term negative impacts of major resource developments on the north's fragile ecology and way of life. Appropriate environmental and socio-economic planning to mitigate the effects of major resource developments takes time and money.

Other Canadian consequences of the greenhouse effect and related environmental and economic impacts are clearly negative in direction and will hold serious consequences for community and regional economies and perhaps for total national income in Canada. In many countries, agriculture is the sector which will be placed most at risk by atmospheric change. The sector most at risk in Canada is likely to be forestry. One potential forestry impact is explored by Hampson and Bush (page 2). A three degree rise in mean temperature in the mid-latitudes of Canada would move the climate belt conducive to hardwood forests about 400 km north. Because this change is likely to occur in less than a century, the forests would not be able to move north because suitable soils could not be created fast enough. Moreover, along the southern borders of Canadian forests, anticipated changes in rain and snow patterns could make trees more vulnerable to fire, pests and weeds. The literature suggests that Canada's softwood forests could be placed under similar pressures. Hampson and Bush conclude therefore that, if the warming trend occurs too quickly, Canada could be in danger of losing many of its forests.

Many small communities on Canada's two coasts are dependent on the harvesting, processing and sale of Canada's fish resources for their economic well being. Altered fish migration patterns resulting from climatic change will add another element of uncertainty to an already unpredictable industry, and likely would add to operating costs as fishermen are forced to travel greater distances and fish longer periods in order to achieve their quotas. Inland fishing could be hurt by reduced water levels in many lakes and rivers, including the Great Lakes and water systems on the Prairies.

It is quite possible that climatic change will place further pressures on the wild animal species which are so important to the livelihood and lifestyle of Canada's northern people. The effects of climatic change, when added to the weak markets and low prices caused by the anti-trapping movement, could seriously effect hunting and trapping and could mean the end of a traditional way of life which is so important to many northern communities and native northerners.

Canadian manufactures will need to adjust to higher energy costs, higher interest rates, changes in their sources of supply for raw materials and intermediate inputs, and to perhaps lower and more unpredictable demands for their products.

Like other countries of the world, Canada's coastal regions will be negatively affected by sea level rise. As pointed out by Hampson and Bush, a one-metre rise will flood many low-lying areas in Prince Edward Island, including much of Charlottetown. The risks of flooding and of shoreline damage will also increase substantially in coastal areas in lower New Brunswick and along the Bay of Fundy. Many coastal towns along the Arctic Ocean could also be flooded. The costs of protecting coastal areas at risk, of maintaining shoreline structures, and of relocating facilities inland, will be considerable and will largely be borne by the Canadian taxpayer.

Because warming will be more extreme in Canada than in countries in the lower latitudes, Canadians will need to be particularly concerned with the increasing risks of skin cancer and related health effects caused by climatic change.

When all factors are considered, it is difficult to argue that Canadians will be better off as a consequence of climatic change. Canadians likely will be warmer, but beyond this "quality of life" benefit, the weight of evidence suggests that Canadian aggregate production and GNP will be lower, per capita disposable income will be reduced, and Canadian living costs will be higher. Moreover, in the absence of effective adaptation strategies, climatic change holds the potential to further widen income disparities within Canada. The regions of Canada which will be most affected by climatic change will be the coastal areas, as well as the regions which are dependent on resource production (agriculture, forestry, fishing, wild animal harvesting, oil and gas production, and coal), and the processing of Canada's resource products. The economies of the more developed regions such as the Golden Triangle of Ontario are likely to be less affected by the greenhouse effect. These regions have diversified manufacturing and service sectors which no longer are closely tied to resource production, and have the financial resources and technical expertise to better cope with the negative effects of climatic change.

At the same time, Canada clearly will be affected less by climatic change than many other countries of the world. As a comparison of Annexes A and B suggests, while Canada will experience a mix of negative and positive effects, the greenhouse effect in other countries could place their total economy in serious peril. Because of Canada's relatively favorable position and because Canada is a major producer and consumer of fossil fuels, the Canadian government and taxpayer will be expected, through aid programs and other instruments, to contribute generously to programs designed to help less developed countries to cope with the greenhouse effect.

Like other countries, Canada will need to address the economic consequences of climatic change through a mix of limitation and adaption strategies. Policy interventions proposed by Hampson and Bush include:

- immediate measures to reduce CO_2 emissions from agricultural and industrial processes;
- sector specific studies on the fishing, lumber, pulp and paper, wheat, energy and other environmentally sensitive sectors which are so important to Canada's traditional economic base and many of our less prosperous regions;
- research on the effects of global environmental changes on Canada's international position as a trading nation.

Hampson and Bush emphasize that the Canadian response to climatic change will require the coordination of actions across all levels of government in Canada. As well, Canada should be prepared to play a prominent role in the organization of a global response strategy.

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